

Space Weather Technical Forecast

Issued on Friday 24 January 2025 at 01:29 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Chance of Moderate geomagnetic storm/G2 intervals this UTC weekend. Isolated R1 Likely throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Activity was at Low levels, with GOES16 registering occasional C-class activity, peaking with a C9.1 observed at 23/0203UTC from AR3961 in the southwest quadrant.

There are currently nine sunspot regions on the Earth-facing disc. AR3961 in the southwest remains the largest region on the disc, with currently an Eki/Beta-Gamma classification, but appears relatively stable. In contrast two regions were seen to grow rapidly through the period: AR3972 in the southeast which now has two faint small delta spots (Dsi/beta-gamma) and AR3965 in the northwest. AR3965 develop so much that it was split into two separate regions, with AR3971 (Dai/beta-gamma) numbered through the period. Remaining regions remained stable or with small changes.

No new Earth-directed Coronal Mass Ejections (CMEs) have been confirmed, despite various small CME's which have been visible in SDO imagery, from AR3959 and mainly AR3961. However, only one new CME is apparent on available coronagraph imagery - a feature seen heading southwest which will be assessed.

Solar Wind / Geomagnetic Activity: Earth appears to be under the residual influence of the fast wind from CH09/-. The solar wind speed, as measured by ACE and DSCOVR at L1 persisted at Slightly Elevated levels, generally between 420 and 460km/s. The solar wind density was complicated according to which observing satellite was employed, but was either average or below average. The IMF was weak, peaking at 7nT, with the north-south component varying between +5/-6nT. The phi angle remained negative (towards the Sun).

The net result of the above solar wind measures was Quiet to Unsettled geomagnetic activity.

Energetic Particles / Solar Radiation: High energy proton flux at GOES18 remained at background levels.

High energy electron flux (greater than 2MeV) at GOES16 was Moderate to High, with a diurnal peak of 1920pfu seen at 23/1635UTC. The associated 24-hour fluence persisted below the Active threshold, reaching 5.47e7 integrated pfu at 24/0001UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate activity is forecast, with isolated M-class flares Likely and with a Slight Chance of isolated X-class flares.

Solar Wind / Geomagnetic Activity: The only coronal hole to feature in the period is the current residual influence of CH09/- and is not expected to significantly influence the geomagnetic forecast with Quiet to Unsettled activity expected at first, and again late in the period.

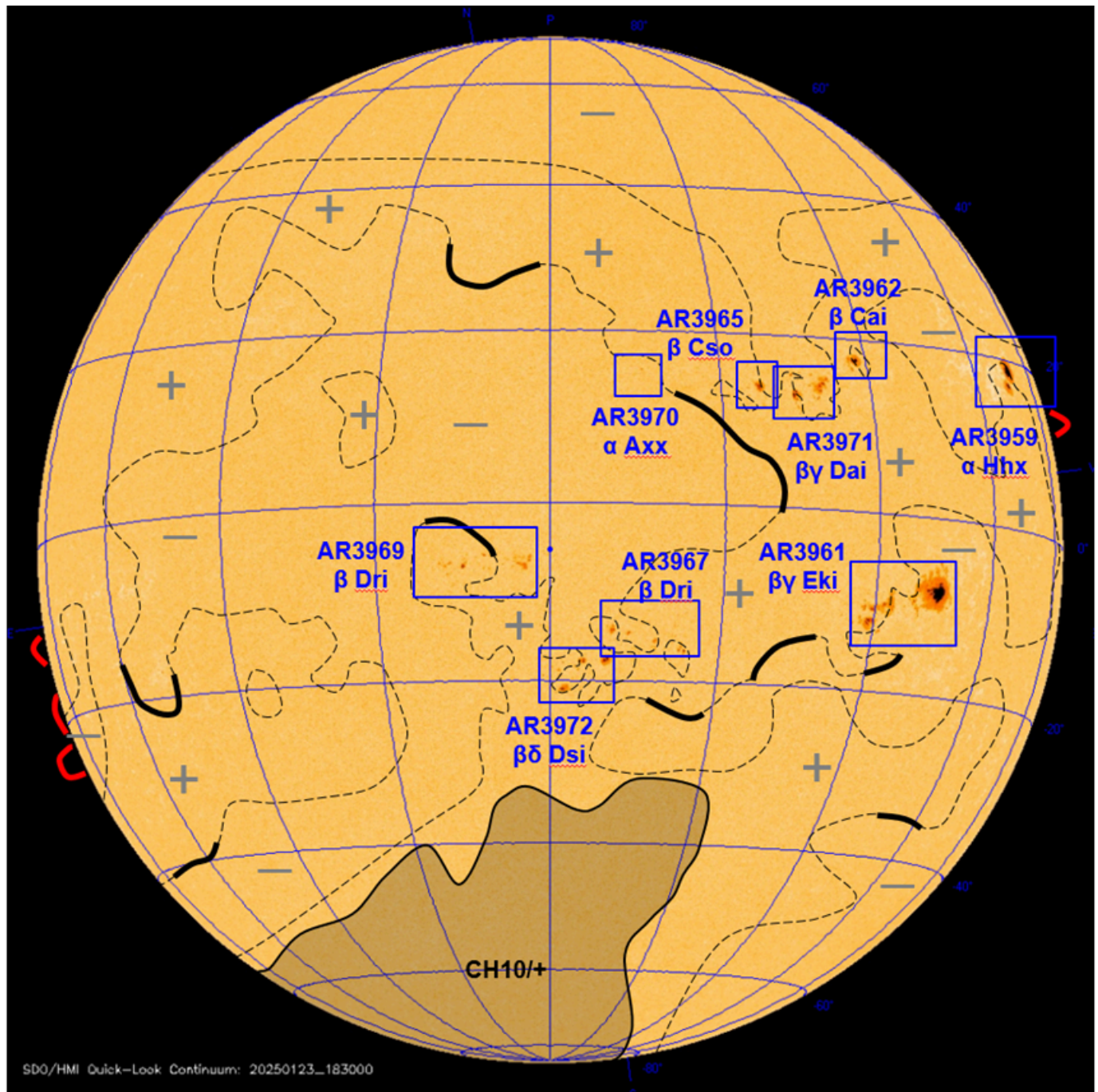
In-between there is a Chance of G2/Moderate geomagnetic storm intervals on Saturday 25 January, with this risk reducing later in the UTC weekend. This is because at least two CMEs are likely to give a glancing blow to Earth - firstly a CME from an M3 from AR3967 on 21 January, and secondly a filament- and M1.3-related event near AR3961 from 22/1108UTC.

A CME seen in imagery leaving the Sun from the southwest on the 23rd appears weak and may be far-sided, as the various small CME's seen in SDO imagery were emitted earlier in the day and from AR3959 and especially AR3961, both in the northwest. Analysis of this CME will be undertaken once enough imagery has become available.

Energetic Particles / Solar Radiation: There remains a Slight Chance of enhancements exceeding the S1 Minor Radiation Storm threshold should any notable flares occur.

GOES16 high energy electron flux is forecast to continue at Moderate to High levels today and perhaps tomorrow (25th) until any CME effects materialise. The corresponding 24 hour fluence is expected to remain below the Active threshold.

Figure 1: Synoptic map valid 23/1830 UTC.



Key: Filament __, Prominence __, Magnetic Field Line ---, Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Geomagnetic Storms

The only coronal hole to feature in the period is the current residual influence of CH09/-, with speeds still Slightly Elevated but much-reduced from their 21 January peak in the upper 600s of km/s. This residual influence is not expected to significantly affect geomagnetic activity.

Currently two CMEs now feature in the forecast - firstly that from an M3 from AR3967 on 21 January, and secondly a filament- and M1.3-related event near AR3961 from 22/1108UTC.

Of the CMEs, the first event is of lesser concern, being modelled in MOSWOC Enlil as a slight glancing blow early in the UTC day of Saturday 25 January. On its own, this might perhaps present a Slight Chance of G1, however it may be rendered more significant for any priming of the Earth's magnetosphere in advance of the later, more direct and larger event from the M1.3. This has been re-analysed as presenting a Chance of Moderate/G2 geomagnetic storms into the UTC evening of Saturday 25 January, with a full halo shock but with the dark helicoidal filament emission (in AIA304) perhaps appearing confined to the southern solar hemisphere (i.e. mainly below the Sun-Earth line). Imagery for the event is reasonable, and speeds obtained from fitting closely match the Type II radio emission estimation of 561km/s (550-600km/s from CME fits). MOSWOC Enlil is currently slightly over-estimating the speeds from the declining phase of CH09/-, which may slightly late-shift the inbound CMEs which otherwise cross 1AU around 25/0600UTC and then 25/1800UTC. The deterministic runs keep these as separate events, however there is a small chance that they coincide (as shown in the MOSWOC Enlil ensemble), which is the reason for the non-zero but not favoured risk of Strong G3. These probabilities then fade through the second half of the weekend (UTC) to leave a Quiet to Unsettled start to the forthcoming new working week.

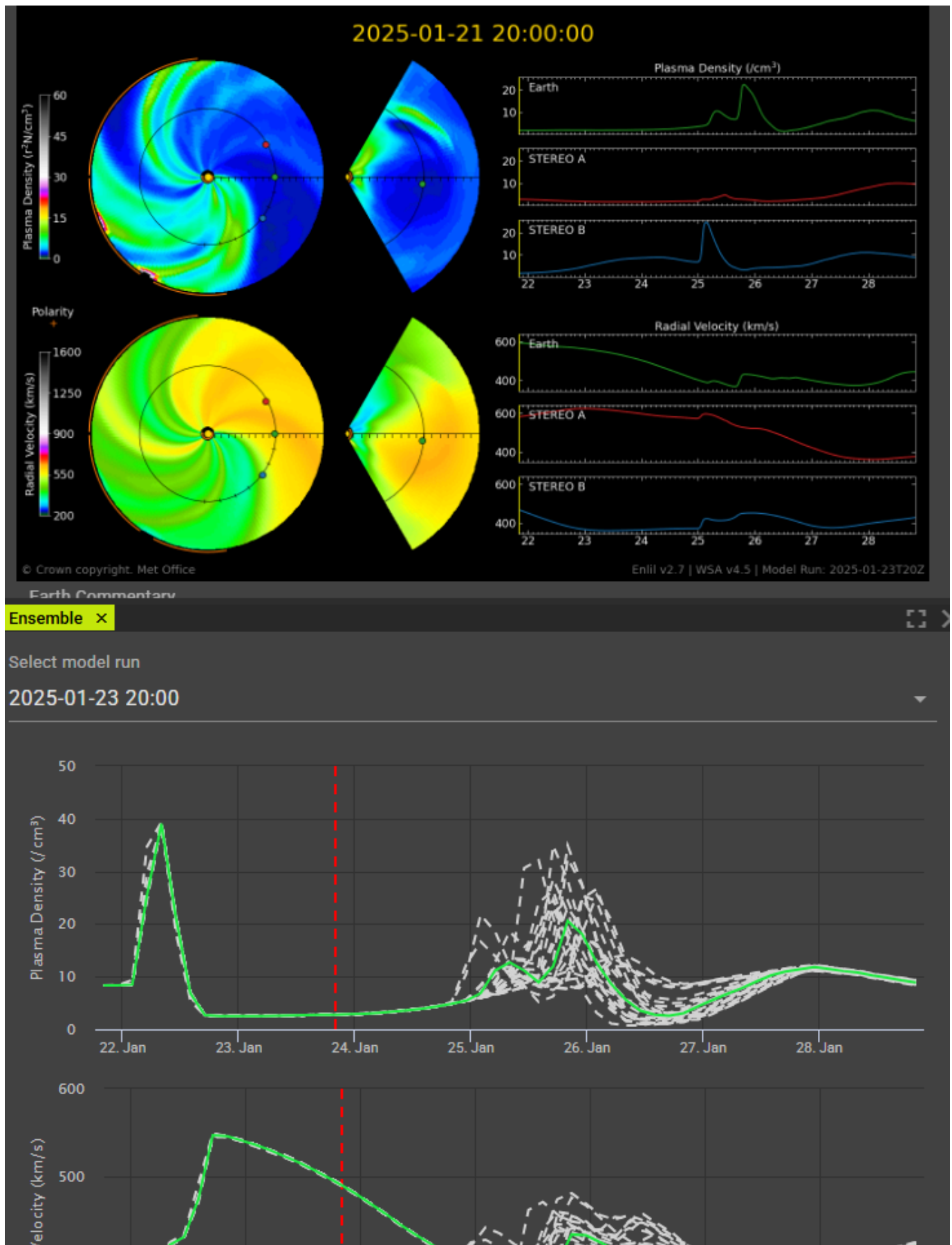
Quiet to Unsettled activity expected at first may give way to a Chance of a Moderate G2 geomagnetic storm, most likely on the 25th. However, there is a not-insignificant alternative possibility that Quiet conditions remain in place throughout the four days - should both CMEs miss.

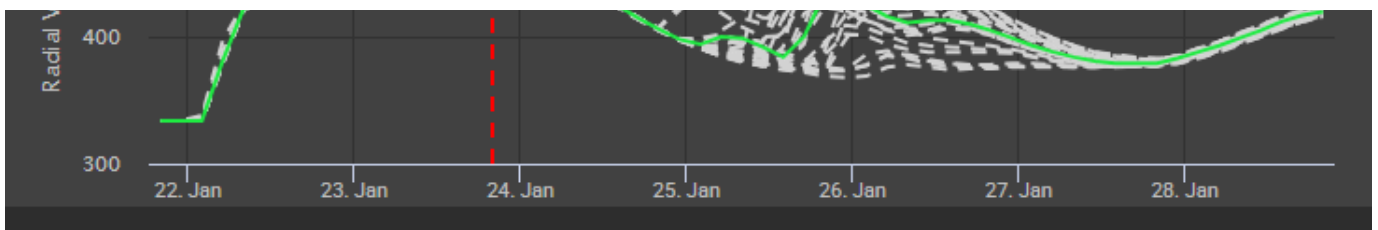
Geomagnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	10	40	30	10
Strong	G3	No	1	15	10	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R_☉ (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed (km/s)	Estimated Arrival Time (UTC)	Comments
21/1027	Partial	AR3967	SE	537	25/0600	Small chance of glance and G1, perhaps primes magnetosphere to increase impacts from later CME.
22/1727	Full	AR3961	S Centre	591	25/1800	Greater chance of glance relative to above, G2 most likely.

Figure 2: Latest MOSWOC Enlil run (top) and Ensemble forecast(bottom), showing the 25th to be the most likely day for both CME's to arrive.





Radio Blackouts - X-Ray Flares

The current Earth-facing disc is showing a westward bias in active region populations, with the far side conversely showing an eastward shift, i.e. diametrically opposite. This means that trends in the coming four-day forecast period will rely on arrivals of regions, with only AR3959 departing, although AR3961 will reach the west limb during day 4 (27th). Arriving regions are likely to occur through the period, these potentially large active regions, as recently large CMEs have been seen emanating from 100-110E.

Overall, the daily Likely M-class flare risk is maintained throughout the period, with any reduction in the global risk from AR3961's slowing output perhaps being helped back upwards by any new east limb arrivals into the UTC weekend. The risk of M-class flares has been revised downwards slightly to fit the current state of the Earth-facing disc.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	No	60	60	60	60
Very Active	R3-R5 (X Class)	No	10	10	10	10

Solar Radiation Storms (High Energy Protons)

High energy proton flux at GOES18 has remained at background levels.

As AR3961 is the largest and most active region on the disc, and probably lead to a recent very slight and temporary increase in the proton flux, AR3961 may be capable of more significant events. Current high energy proton counts add little to the daily probability of exceedence given their modest magnitude, however a slight day-on-day increase in a Slight Chance of S1 is suggested, given the westward advance of a westward-biased disc (in terms of sunspot population).

Radiation Storms	Level (cm ⁻² sr ⁻¹ s ⁻¹)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	15	20	20	20
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = cm ⁻² sr ⁻¹ s ⁻¹)						

High Energy Electrons ($\geq 2\text{MeV}$)

High energy electron flux observed at GOES16 has shown a recent diurnal peak of High flux. This has arisen from the declining phase of connection to CH09/-, with this driving feature now lying on the western limb and no further coronal holes due in the forecast period. Further Moderate to diurnally High levels are expected today and perhaps tomorrow, before the potential CME arrivals. Thereafter a rapid decline is expected, to Background levels, before a possible recovery late in the period with Moderate flux levels returning. However, confidence is low because of the uncertainty around the CME arrivals and their geomagnetic impact. Flux levels may remain Moderate to High for much of the time.

The corresponding 24 hour fluence is expected to remain below the Active threshold, with a gradual downward trend. Therefore the MOSWOC REFM model is considered to be giving reasonable guidance.

GEO Electron Environment	Level ($\text{cm}^{-2}\text{sr}^{-1}\text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2\text{ MeV}$ $\geq 1\times 10^8$	No	20	20	5	5
Very Active	$\geq 2\text{ MeV}$ $\geq 1\times 10^9$	No	1	1	1	1

Figure 3: 24 hours Electron Flux (top) and latest MOSWOC REFM (bottom).

